Embedded Linux
3D Sensing

Minnowboard meets RealSense

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Instituto Tecnológico Superior
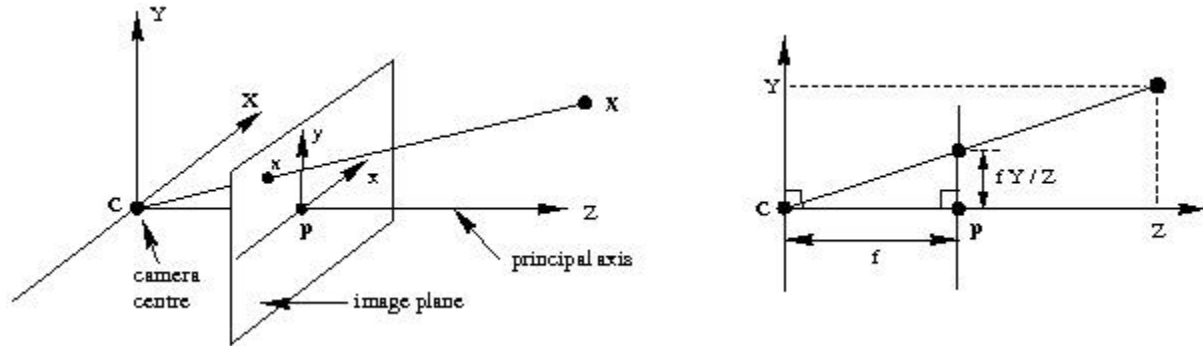*"Saber para trascender"*

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Agenda

- 3D Sensing overview
- Intel® RealSense™ Technology
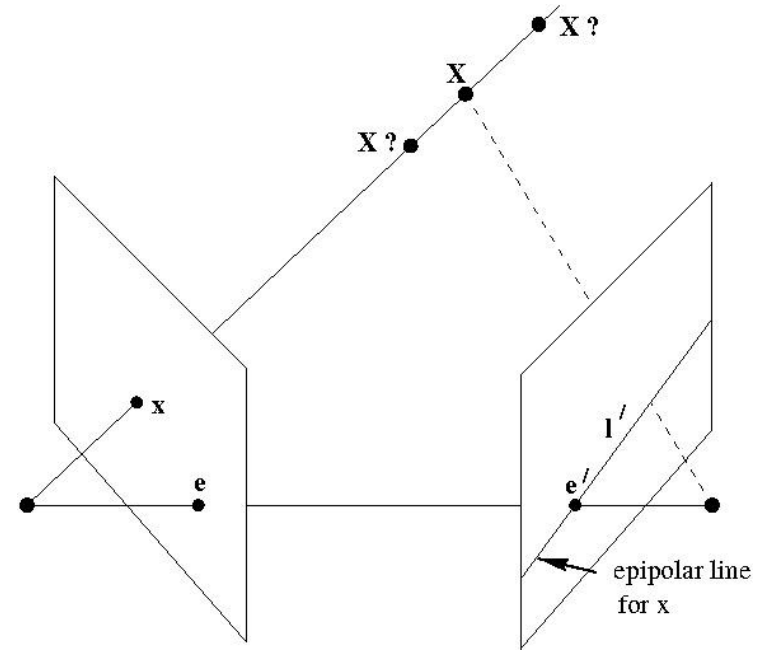- MinnowBoard Max
- librealsense
- Others boards

3D Sensing overview

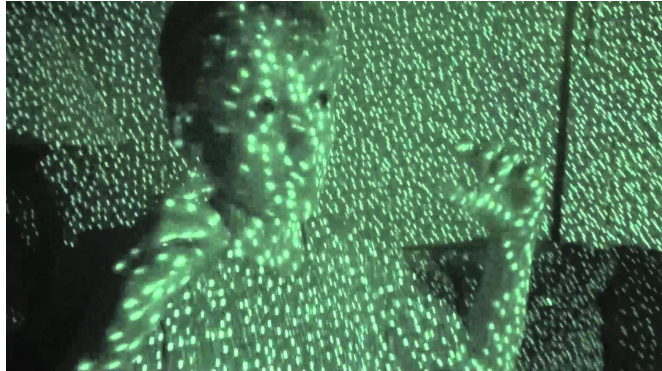Camera model & intrinsic calibration values

3D Sensing overview

- Get each camera model

- Two viewers to get a 3D point

- Disparity image

3D Sensing overview

2010 Microsoft Kinect

Projected dotted grid

3D sensing overview

- A little big to do portable or embedded systems.

Image sources: http://www.engadget.com/2011/03/17/navi-hack-uses-a-kinect-to-let-the-blind-see-wear-awesome-headg/

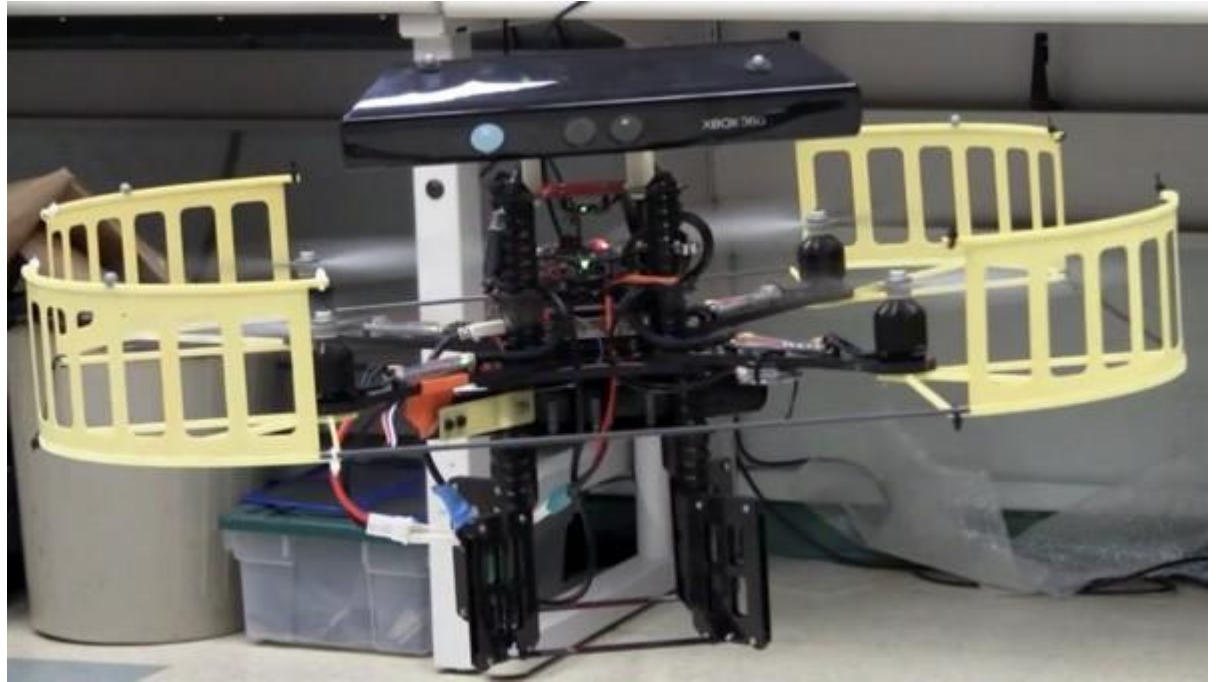# 3D sensing overview

- Also to use with a drone.

Image sources: http://www.slashgear.com/kinect-quadrocopter-is-your-autonomous-ar-drone-video-06117764/

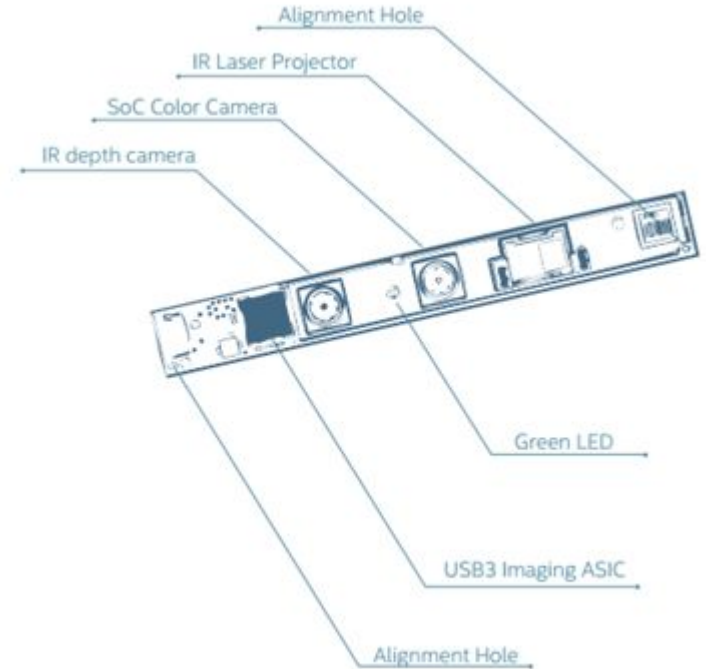# Intel® RealSense™ Technology

Short Range camera

Long Range camera

Intel® RealSense™ Technology (F200)

The F200 is Intel's first-generation coded light camera using a high-frequency MEMS mirror to project a 2D greycode pattern.
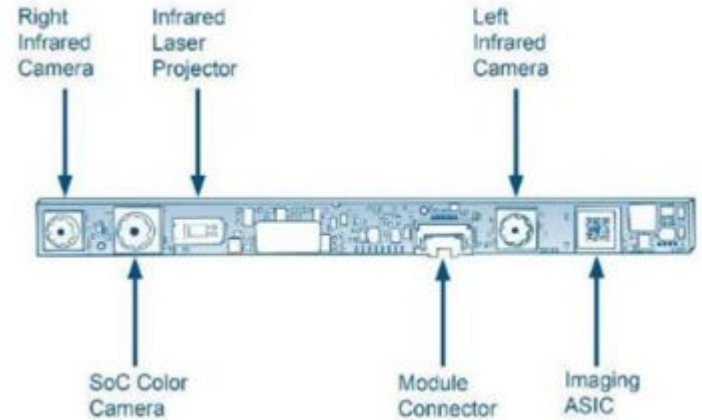
Intel® RealSense™ Technology (R200)

The R200 is an active stereo camera with a 70mm baseline.

Works in disparity space and has a maximum search range of 63 pixels horizontally

Outdoors, the laser has no effect over ambient infrared from the sun. Furthermore, at default settings, IR sensors can become oversaturated in a fully sunlit environment so gain/exposure/fps tuning might be required.

Right Infrared Camera

Infrared Laser Projector

Left Infrared Camera

SoC Color Camera

Module Connector

Imaging ASIC

Camera specifications

	R200	F200	SR300
Indoor Range	0.7 m - 3.5 m	0.2 m - 1.0 m	0.2 m - 1.5 m
Outdoor Range	10 m	N/A	N/A
Depth FoV (DxWxH)	70 x 59 x 46	80 x 68 x 54	80 x 68 x 54
Depth FPS	30, 60, 90	30, 60	30, 60
IR FPS	30, 60, 90	30 - 300	30 - 300
Depth method	Active Stereo IR	Coded light IR	Coded light IR
Minimum F/W	1.0.72.04	2.60.0.0	3.10.10.0

MinnowBoard Max
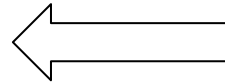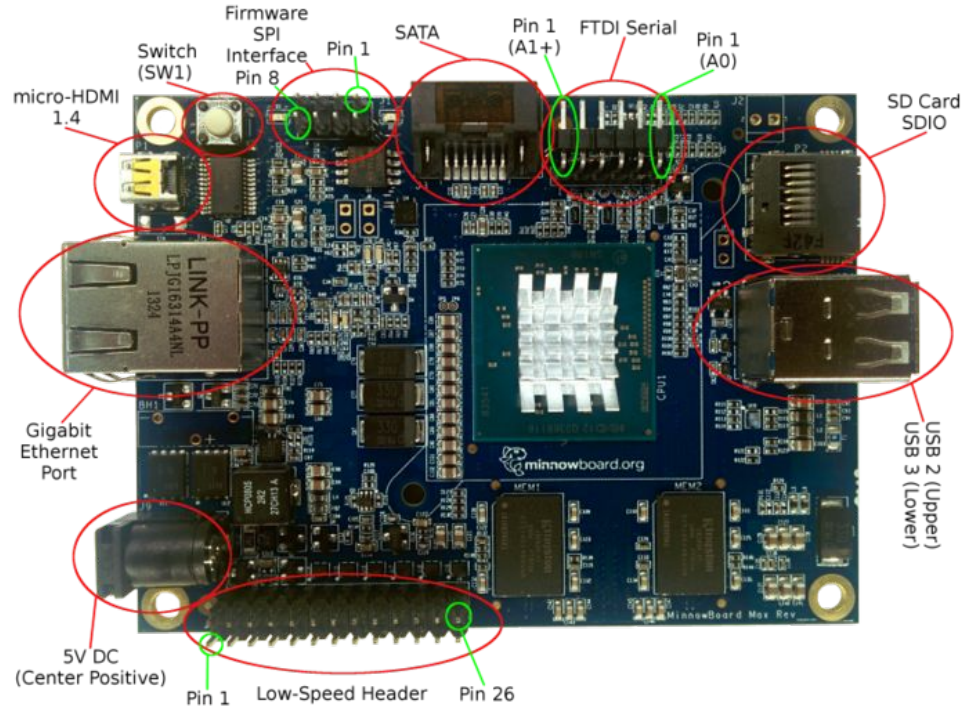
Size matters

Librealsense

- Is a cross-platform library (**Linux**, **OSX**, **Windows**)
- Capturing data from the Intel® RealSense™ **F200**, **SR300** and **R200** cameras.
- Only encompasses **camera capture functionality** without additional computer vision algorithms.
- To support researchers, creative coders, and app developers
  - Robotics, virtual reality, and the internet of things (IoT).

https://github.com/IntelRealSense/librealsense

Librealsense

- This project *is separate from the production software* stack available in the Intel® RealSense™ SDK
- Librealsense **is experimental** and **not an official Intel product**.
- Does not currently provide functionality to upload new firmware

Principal Developers

- Dimitri Diakopoulos
- Sterling Orsten

Compatible Devices

1. RealSense R200

2. RealSense F200

3. RealSense SR300

Compatible platforms

It is developed and tested on the following platforms:

1. Windows 8.1 (Visual Studio 2013 Update 5)
2. Ubuntu 14.04.03 LTS x64 (GCC 4.9 toolchain)
3. Mac OS X 10.7+ (Clang toolchain)

It may be possible to compile and run librealsense on other platforms.

Supported Languages and Frameworks

- librealsense is written in standards-conforming C++11
  - C - Core library API exposed via the C89 ABI
  - C++ - Single header file (rs.hpp) wrapper around C API, providing classes and exceptions

Functionality

1. **Native streams**: depth, color, infrared
2. **Synthetic streams**: rectified images, depth aligned to color and vice versa, etc.
3. **Intrinsic/extrinsic** calibration information
4. Majority of hardware-specific functionality for individual camera generations (UVC XU controls)
5. Multi-camera capture across heterogeneous camera architectures (e.g. mix R200 and F200 in same application)

How it works?
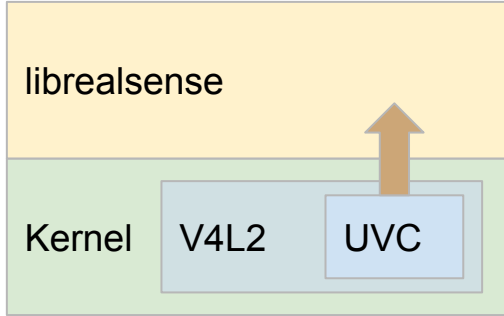
- librealsense communicates with RealSense™ devices directly via the UVC and USB protocols.
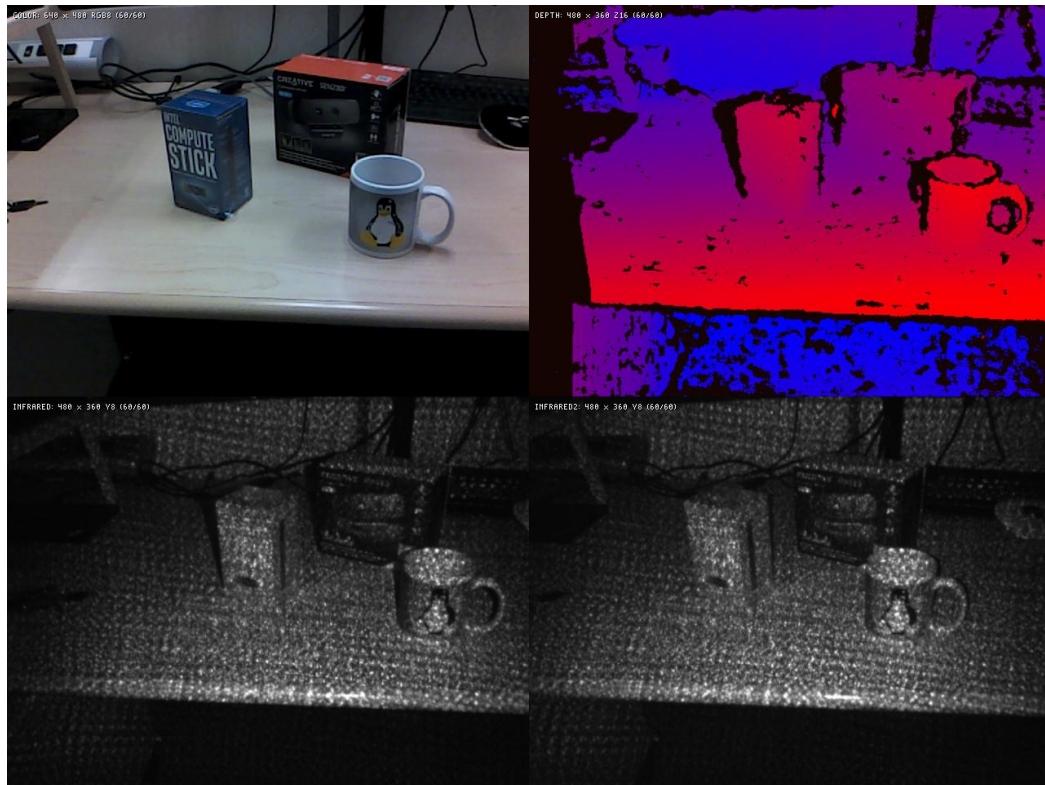
- A kernel patch is needed.

Integrations

librealsense has been integrated with a number of third-party components and operating systems.

- Robotic Operating System (Intel Supported, R200 Only)
  - https://github.com/intel-ros/realsense
- Yocto / WindRiver Linux
  - https://github.com/IntelRealSense/meta-intel-librealsense
- Arch Linux
  - https://aur.archlinux.org/packages/librealsense/
- Clear Linux Project for Intel® Architecture
  - https://clearlinux.org/ (coming soon)
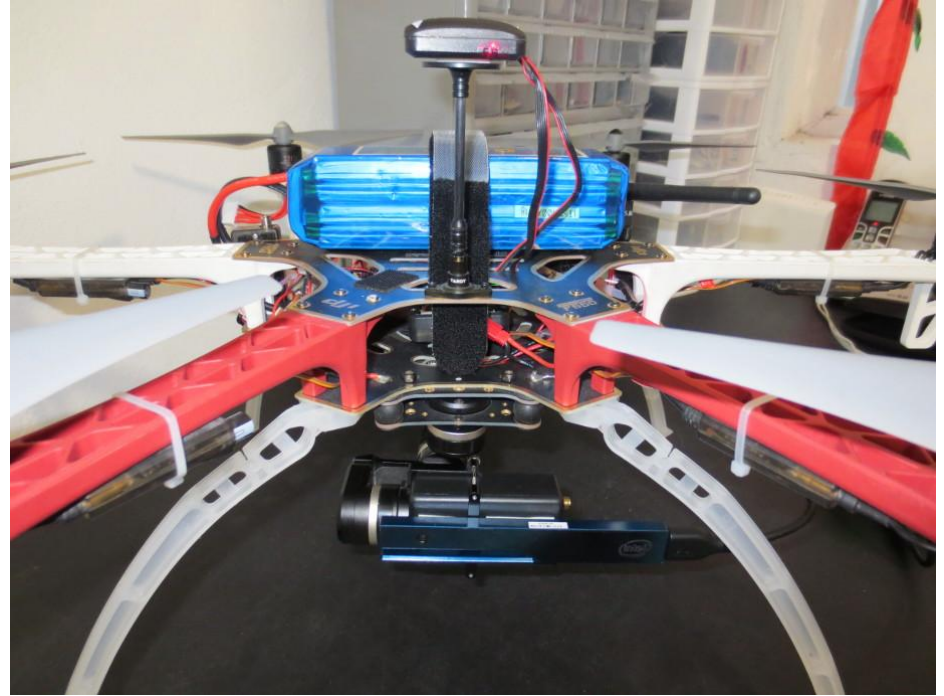
Simple capture

3D cloud point
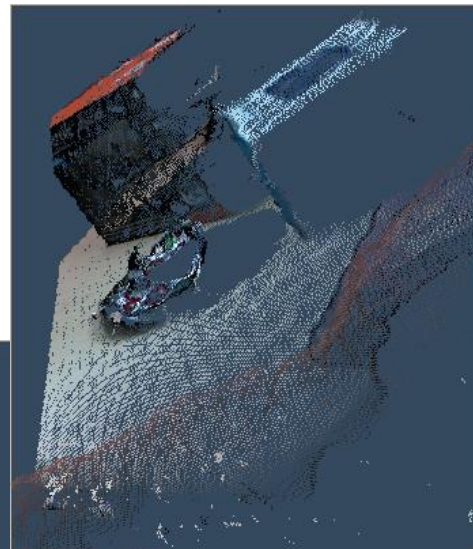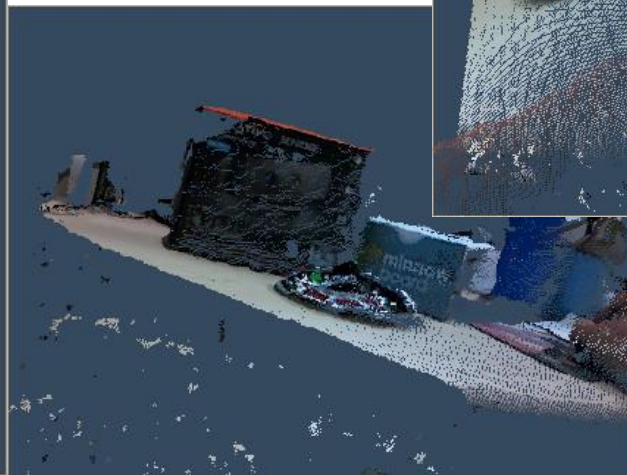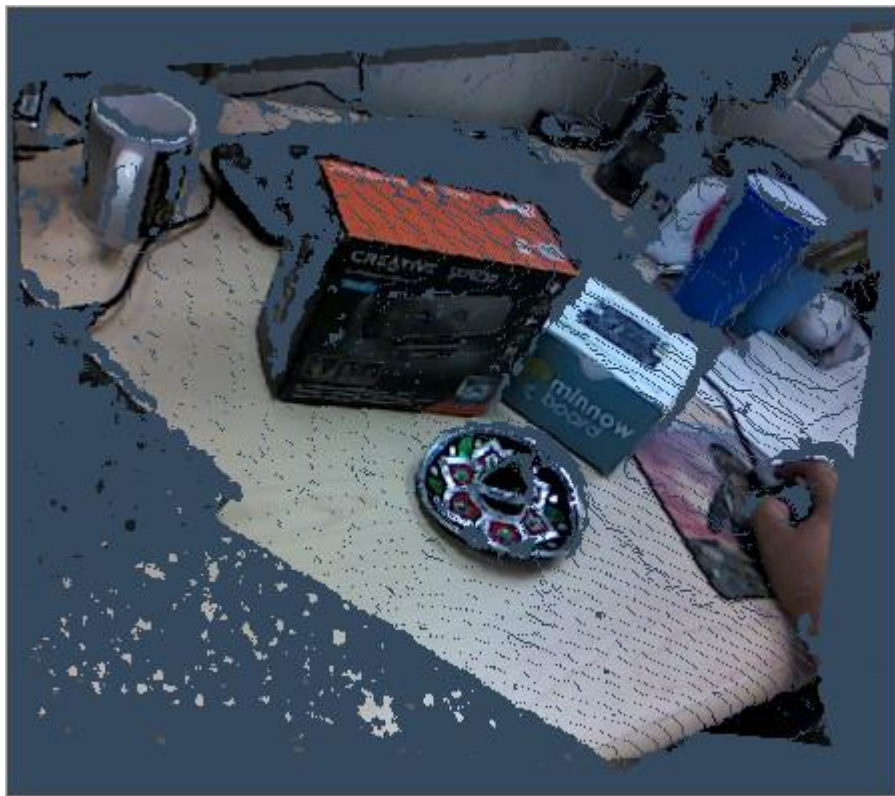
Drone setup

- 6 rotor drone
- GoPro 4

Drone setup

- 6 rotor drone
- Minnowboard
- R200 RealSense camera

Other boards

- Intel Compute Stick (BOXSTK1AW32SCR)

- Kangaroo MD2B

- UP Board

How to get one?

Developer kits containing the necessary hardware to use this library are available for purchase at http://click.intel.com/realsense.html.

Acknowledges

Edward Ulises Benítez Rendón

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"Saber para trascender"

Q / A

Thank you

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